CHAPTER 5

PIPING SYSTEMS

When you have read and understood this chapter, you should be able to answer the following learning objectives:

- *Interpret piping blueprints.*
- *Identify shipboard hydraulic and plumbing blueprints.*

PIPING DRAWINGS

Water was at one time the only important fluid that was moved from one point to another in pipes. Today almost every conceivable fluid is handled in pipes during its production, processing, transportation, and use. The age of atomic energy and rocket power has added fluids such as liquid metals, oxygen, and nitrogen to the list of more common fluids such as oil, water, gases, and acids that are being carried in piping systems today. Piping is also used as a structural element in columns and handrails. For these reasons, drafters and engineers should become familiar with pipe drawings.

Piping drawings show the size and location of pipes, fittings, and valves. A set of symbols has been developed to identify these features on drawings. We will show and explain the symbols later in this chapter.

Two methods of projection used in pipe drawings are orthographic and isometric (pictorial). Chapter 3 has a general description of these methods and the following paragraphs explain their use in pipe drawings.

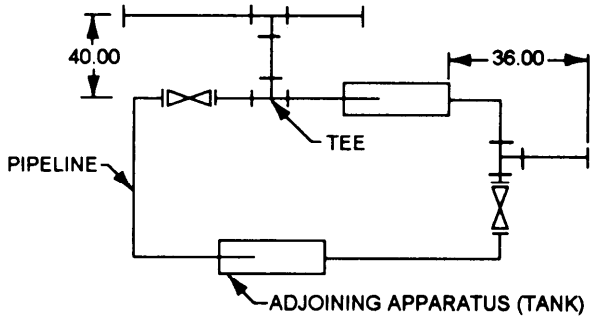


Figure 5-1.—Single-line orthographic pipe drawing.

ORTHOGRAPHIC PIPE DRAWINGS

Single- and double-line orthographic pipe drawings (fig. 5-1 and 5-2) are recommended for showing single pipes either straight or bent in one plane only. This method also may be used for more complicated piping systems.

ISOMETRIC (PICTORIAL) PIPE DRAWINGS

Pictorial projection is used for all pipes bent in more than one plane, and for assembly and layout work. The finished drawing is easier to understand in the pictorial format.

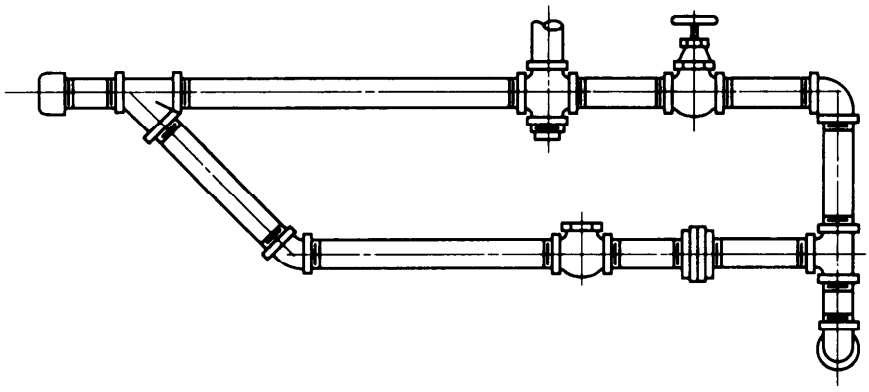


Figure 5-2.—Double-line orthographic pipe drawing.

Draftsmen use single-line drawings to show the arrangement of pipes and fittings. Figure 5-3 is a single-line (isometric) pictorial drawing of figure 5-1. The center line of the pipe is drawn as a thick line to which the valve symbols are added.

Single-line drawings take less time and show all information required to lay out and produce a piping system.

Double-line pipe drawings (fig. 5-4) require more time to draw and therefore are not recommended for production drawings. Figure 5-4 is an example of a double-line pictorial pipe drawing. They are generally used for catalogs and similar applications where visual appearance is more important than drawing time.

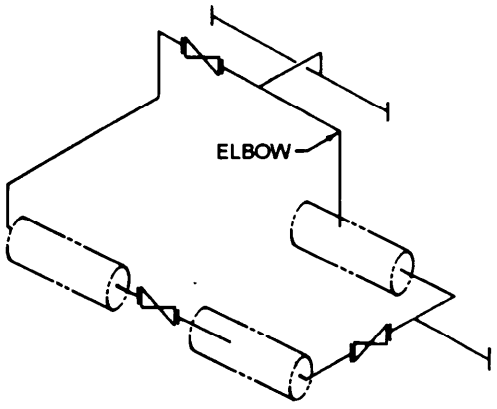


Figure 5-3.—Single-line pictorial piping drawing of figure 5-1.

CROSSINGS

The crossing of pipes without connections is normally shown without interrupting the line representing the hidden line (fig. 5-5, view A). But when there is a need to show that one pipe must pass behind another, the line representing the pipe farthest from the viewer will be shown with a break, or interruption, where the other pipe passes in front of it, as shown in figure 5-5, view B.

CONNECTIONS

Permanent connections, whether made by welding or other processes such as gluing or soldering, should be shown on the drawing by a heavy dot (fig. 5-6). The draftsman normally will use a general note or specification to describe the type of connection.

Detachable connections are shown by a single thick line (figs. 5-6 and 5-7). The specification, a general note, or bill of material will list the types of connections such as flanges, unions, or couplings and whether the fittings are flanged or threaded.

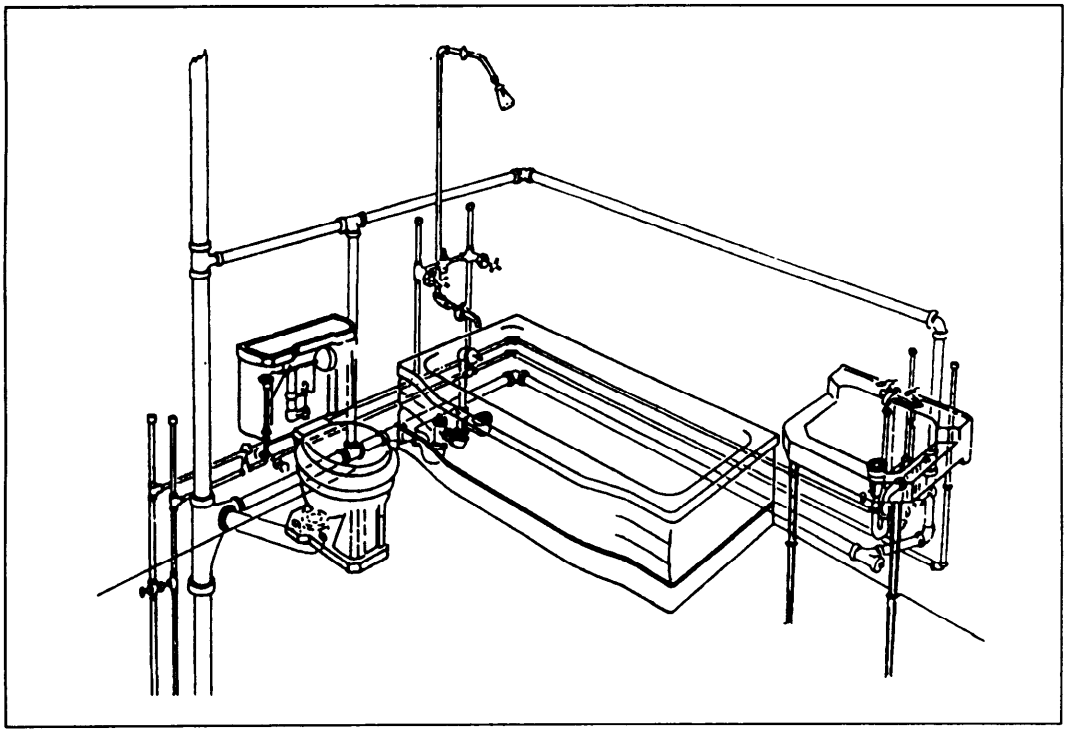


Figure 5-4.—Double-line pictorial piping drawing.

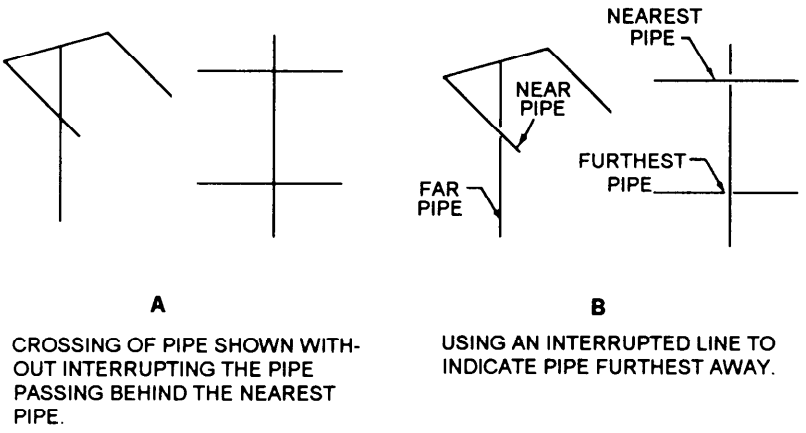


Figure 5-5.—Crossing of pipes.

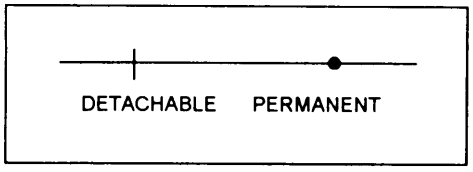


Figure 5-6.—Pipe connection.

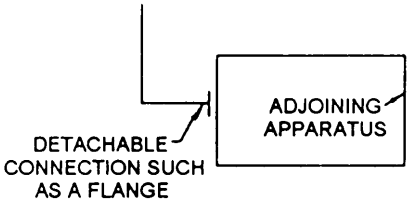


Figure 5-7.—Adjoining apparatus.

FITTINGS

If standard symbols for fittings like tees, elbows, crossings, and so forth are not shown on a drawing, they are represented by a continuous line. The circular symbol for a tee or elbow may be used when it is necessary to show the piping coming toward or moving away from the viewer. Figure 5-8, views A and B, show circular symbols for a connection with and without flanges.

Symbols and Markings

MIL-STD-17B, part I, lists mechanical symbols used on piping prints other than those for aeronautical, aerospacecraft, and spacecraft, which are listed in MIL-STD-17B, part II. Figure 5-9 shows common symbols from MIL-STD-17B, part I. Note that the symbols may show types of connections

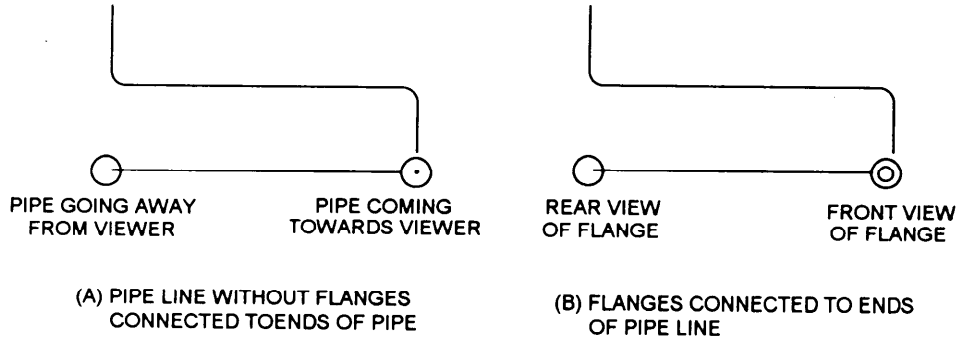


Figure 5-8.—Indicating ends of pipe and fittings.

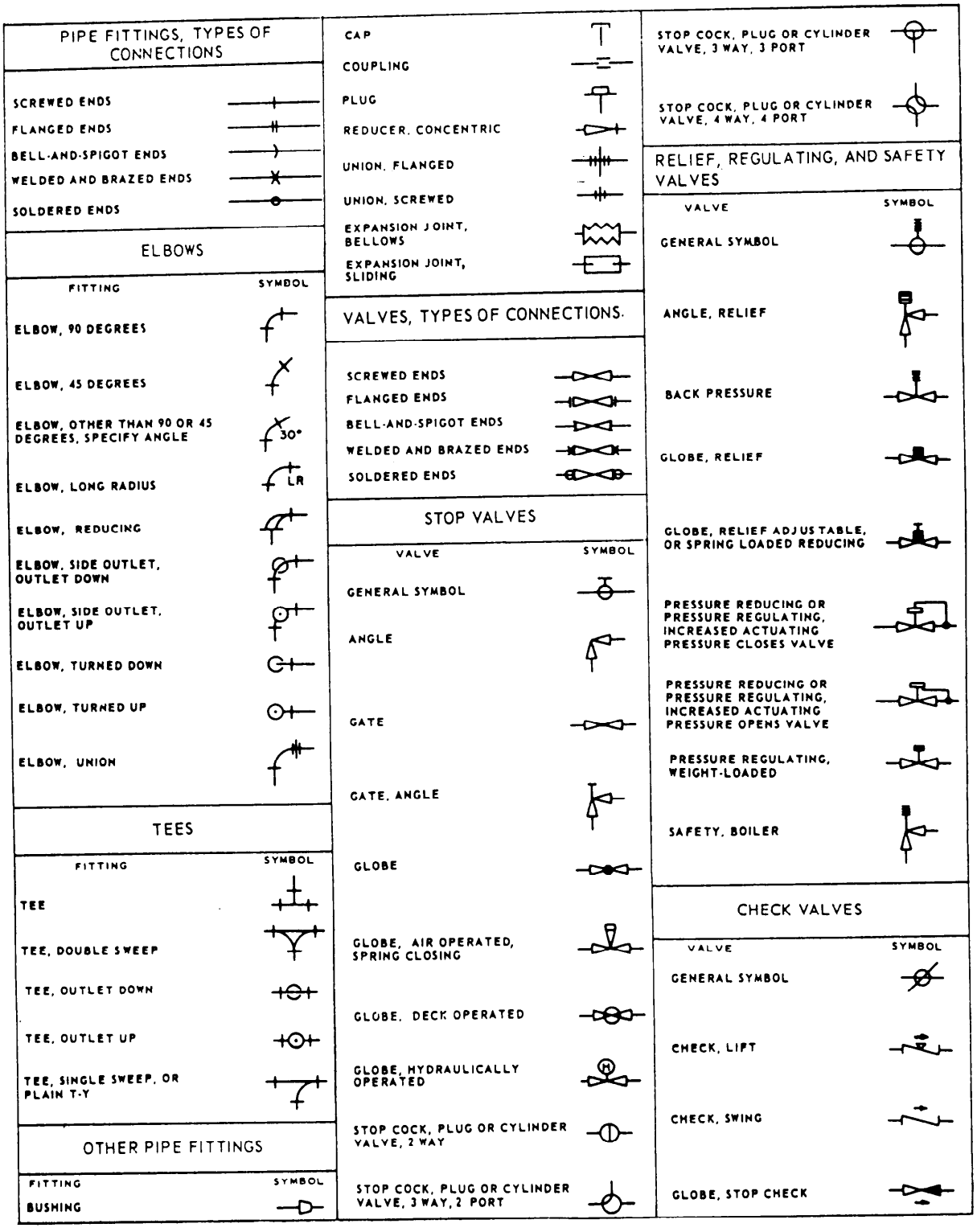


Figure 5-9.—Symbols used in engineering plans and diagrams.

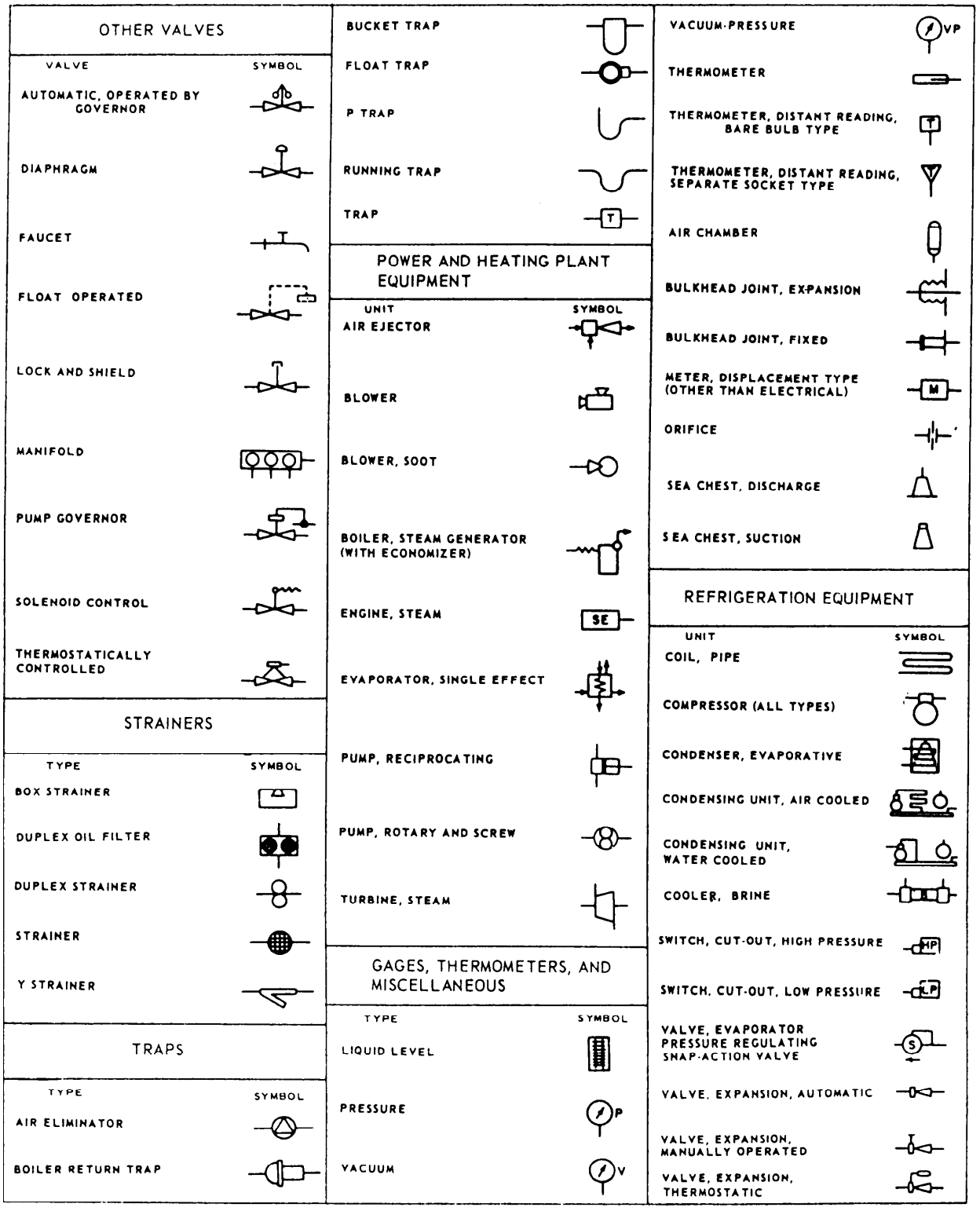


Figure 5-9.—Symbols used in engineering plans and diagram—Continued.

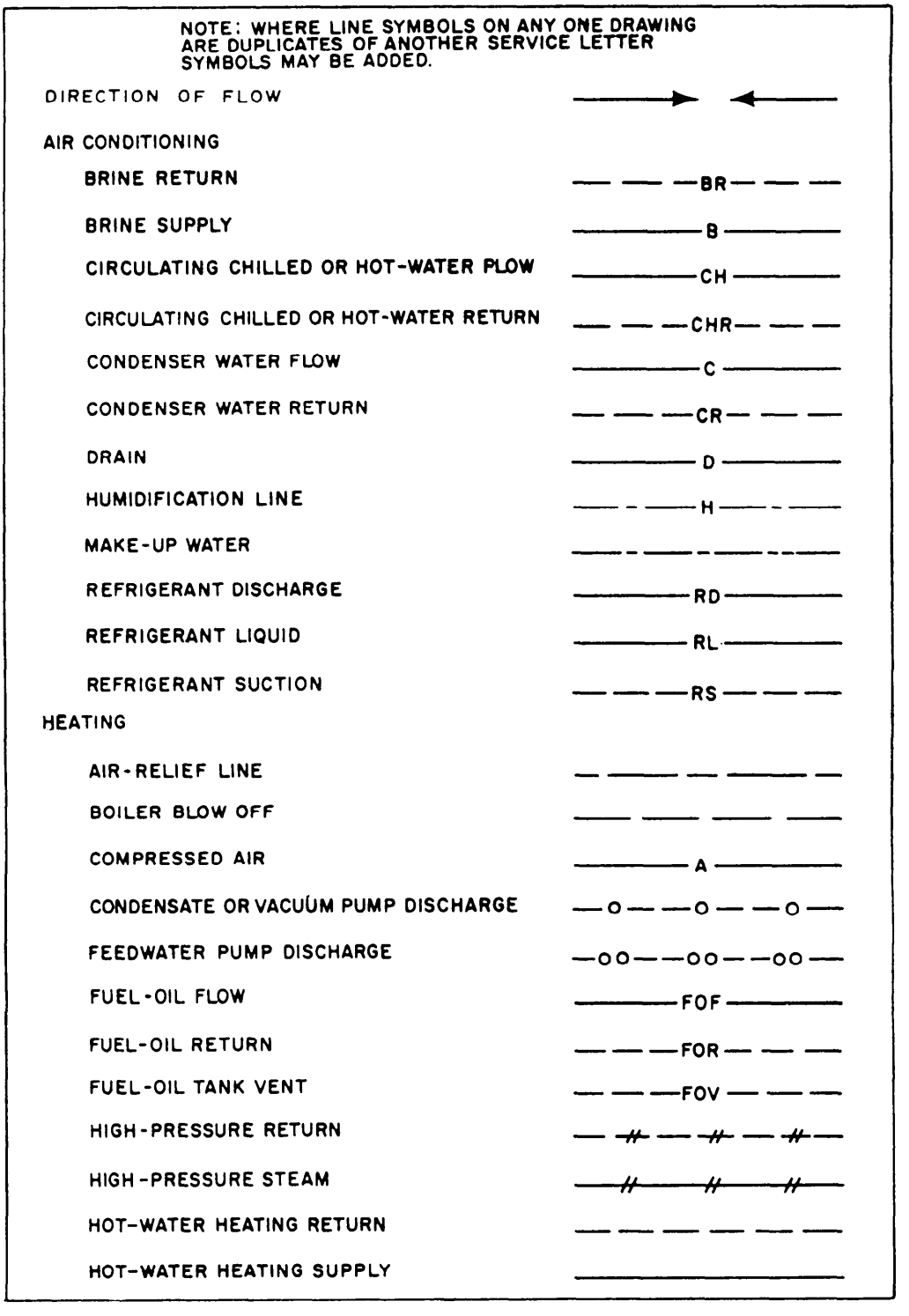


Figure 5-10.—Pipe line symbols.

(screwed, flanged, welded, and so forth) as well as fittings, valves, gauges, and items of equipment. When an item is not covered in the standards, the responsible activity designs a suitable symbol and explains it in a note.

Figure 5-10 shows some of the common piping symbols used in piping prints. When a print shows more than one piping system of the same kind, additional letters are added to the symbols to differentiate between the systems.

MIL-STD-101C established the color code used to identify piping carrying hazardous fluids. It applies to all piping installations in naval industrial plants and shore stations where color coding is used. While all valve wheels on hazardous fluid piping must be color coded, the piping itself is optional. The following colors are painted on valve wheels and pipe lines carrying hazardous fluids:

Yellow — Flammable materials

Brown — Toxic and poisonous materials

Blue — Anesthetics and harmful materials

Green — Oxidizing materials

Gray — Physically dangerous materials

Red — Fire protection materials

Fluid lines in aircraft are marked according to MIL-STD-1247C, *Markings, Functions, and Designations of Hoses, Piping, and Tube Lines for Aircraft, Missiles, and Space Systems.* Figure 5-11 lists the types of aircraft fluid lines with the color code and symbol for each type. Aircraft fluid lines are also

FUNCTION	COLOR	SYMBOL
Fuel	Red	
Rocket Oxidizer	Green, Gray	
Rocket Fuel	Red, Gray	
Water Injection	Red, Gray, Red	
Lubrication	Yellow	
Hydraulic	Blue, Yellow	
Solvent	Blue, Brown	
Pneumatic	Orange, Blue	
Instrument air	Orange, Gray	
Coolant	Blue	
Breathing Oxygen	Green	
Air Conditioning	Brown, Gray	
Monopropellant	Yellow, Orange	
Fire Protection	Brown	
Deicing	Gray	
Rocket Catalyst	Yellow, Green	
Compressed gas	Orange	
Electrical Conduit	Brown, Orange	
Inerting	Orange, Green	

Figure 5-11.—Aircraft fluid line color code and symbols.

marked with an arrow to show direction of flow and hazard marking, as you will see later in this chapter. The following paragraphs contain markings for the four general classes of hazards, and figure 5-12 shows examples of the hazards in each class.

FLAM — This marking identifies all materials ordinarily known as flammable or combustible.

TOXIC — This marking identifies materials that are extremely hazardous to life or health.

AAHM — This marking identifies anesthetics and harmful materials. These include all materials that produce anesthetic vapors. They also include those that do not normally produce dangerous fumes or vapors, but are hazardous to life and property.

PHDAN — This marking identifies a line that carries material that is not dangerous in itself, but is asphyxiating in confined areas. These materials are generally handled in a dangerous physical state of pressure or temperature.

SHIPBOARD PIPING PRINTS

There are various types of shipboard piping systems. Figure 5-13 shows a section of a piping diagram for a heavy cruiser. Note that the drawing uses the standard symbols shown in figure 5-9, and that it includes a symbol list. Some small piping diagrams do not include a symbol list; therefore, you must be familiar with the standard symbols to interpret these diagrams.

Standard symbols are generally not used in drawings of shipboard piping systems found in operation and maintenance manuals. Each fitting in those systems may be drawn in detail (pictorially), as shown in figure 5-14, or a block diagram arrangement (fig. 5-15) may be used.

HYDRAULIC PRINTS

The Navy has increased its use of hydraulic systems, tools, and machines in recent years. Hydraulic systems are used on aircraft and aboard ship to activate weapons, navigational equipment, and remote controls of numerous mechanical devices. Shore stations use hydraulically operated maintenance and repair shop equipment. Hydraulic systems are also used in construction, automotive, and weight-handling equipment. Basic hydraulic principles are discussed in the basic training course *Fluid Power*, NAVEDTRA 12064.

To help you distinguish one hydraulic line from another, the draftsman designates each line according

FLUID	HAZARD
Air (under pressure)	PHDAN
Alcohol	FLAM
Carbon dioxide	PHDAN
FREON	PHDAN
Gaseous oxygen	PHDAN
Liquid nitrogen	PHDAN
LPG (liquid petroleum gas)	FLAM
Nitrogen gas	PHDAN
Oils and greases	FLAM
JP-5	FLAM
Trichloroethylene	AAHM

Figure 5-12.—Hazards associated with various fluids.

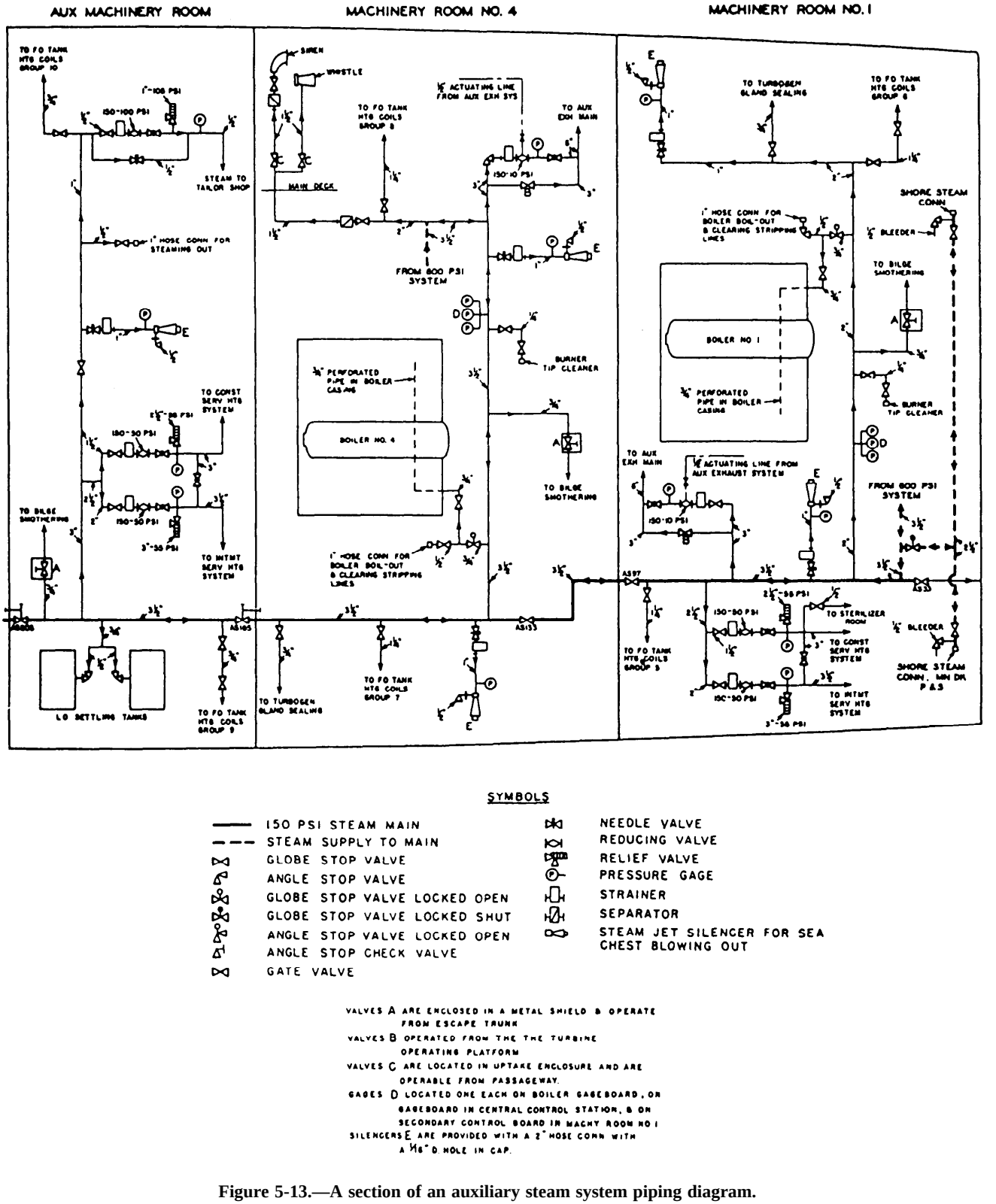


Figure 5-13.—A section of an auxiliary steam system piping diagram.

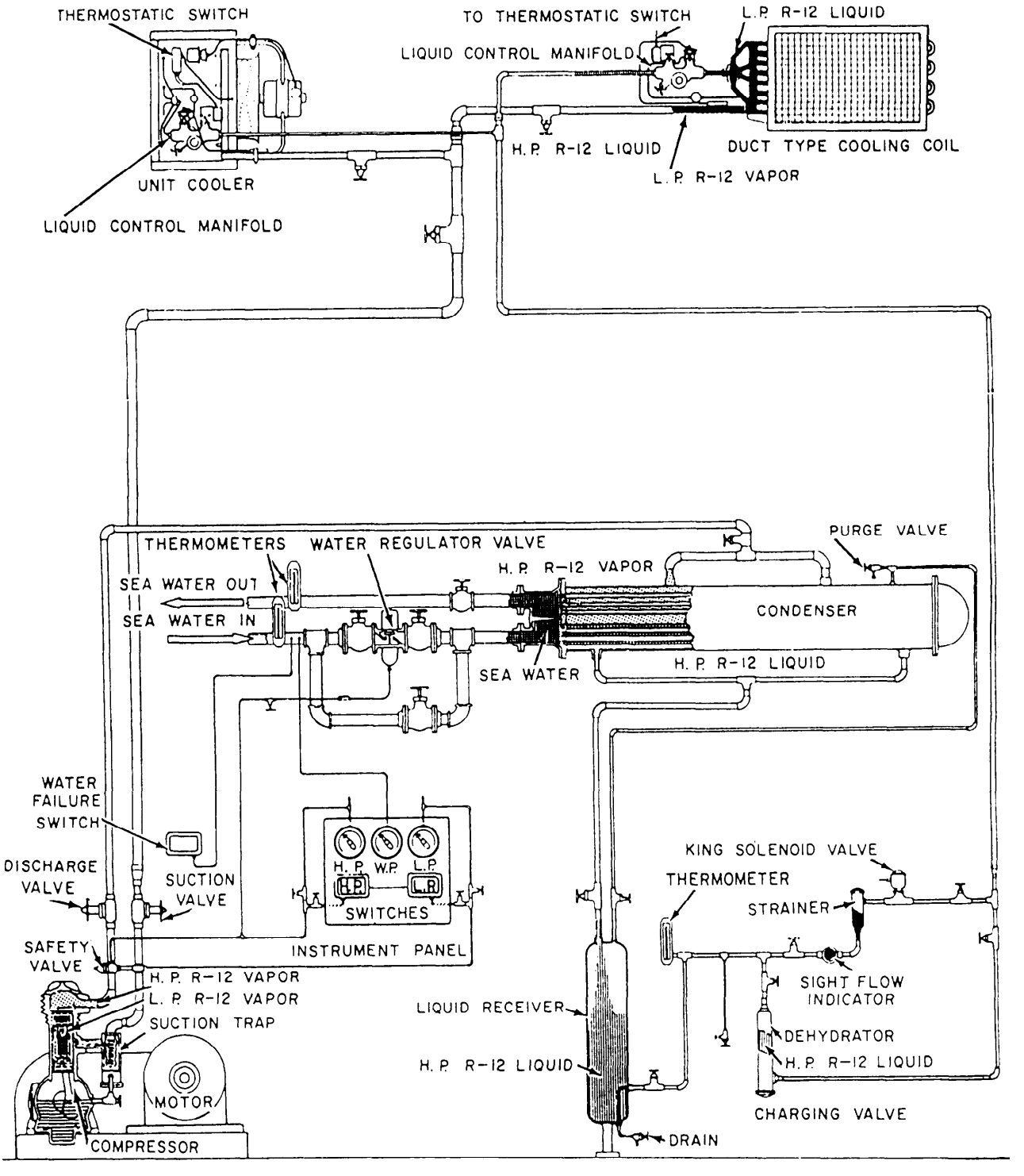


Figure 5-14.—Shipboard refrigerant circulating air-conditioning system.

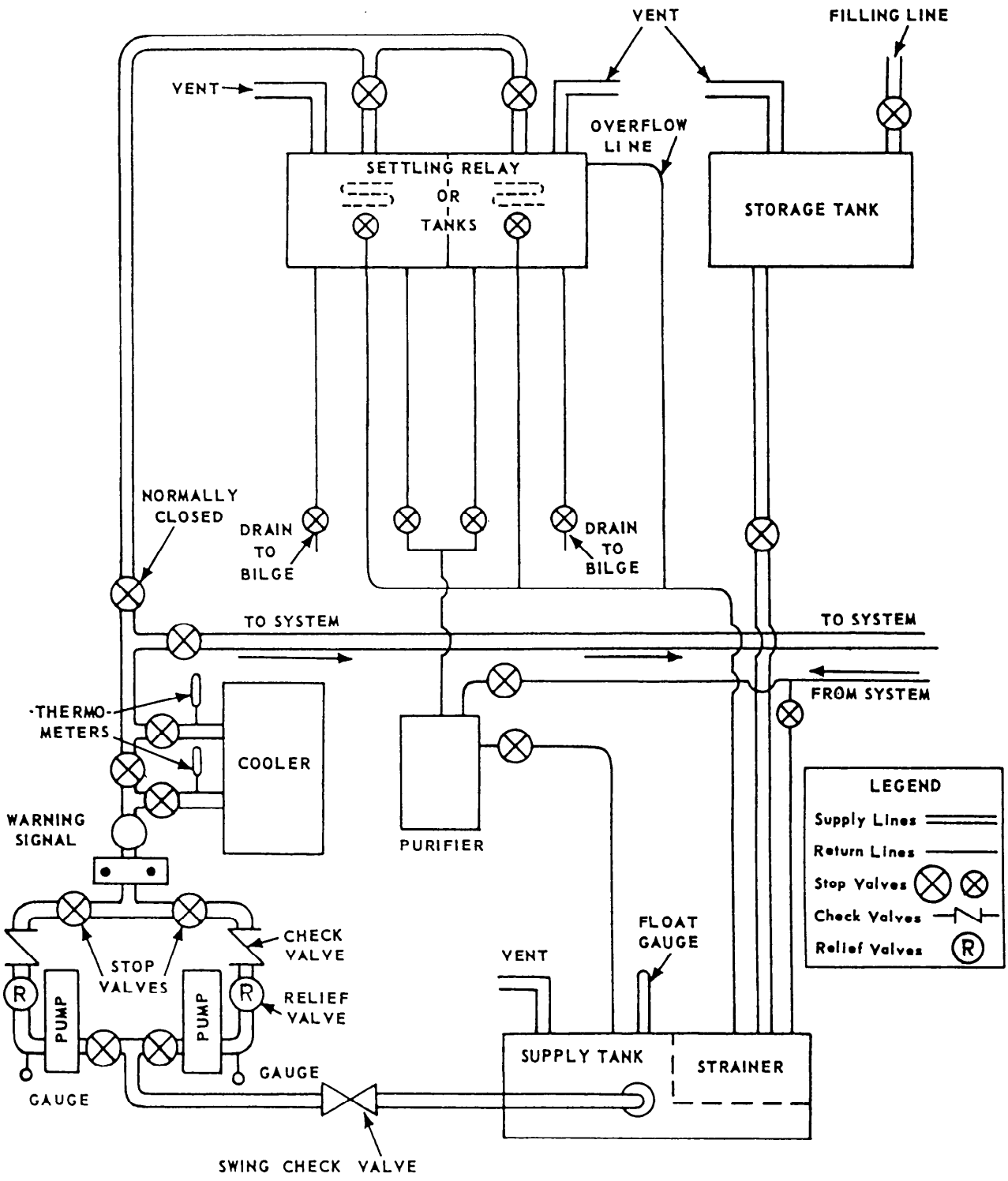


Figure 5-15.—Shipboard forced-lubrication system.

to its function within the system. In general, hydraulic lines are designated as follows:

SUPPLY LINES—These lines carry fluid from the reservoir to the pumps. They may be called suction lines.

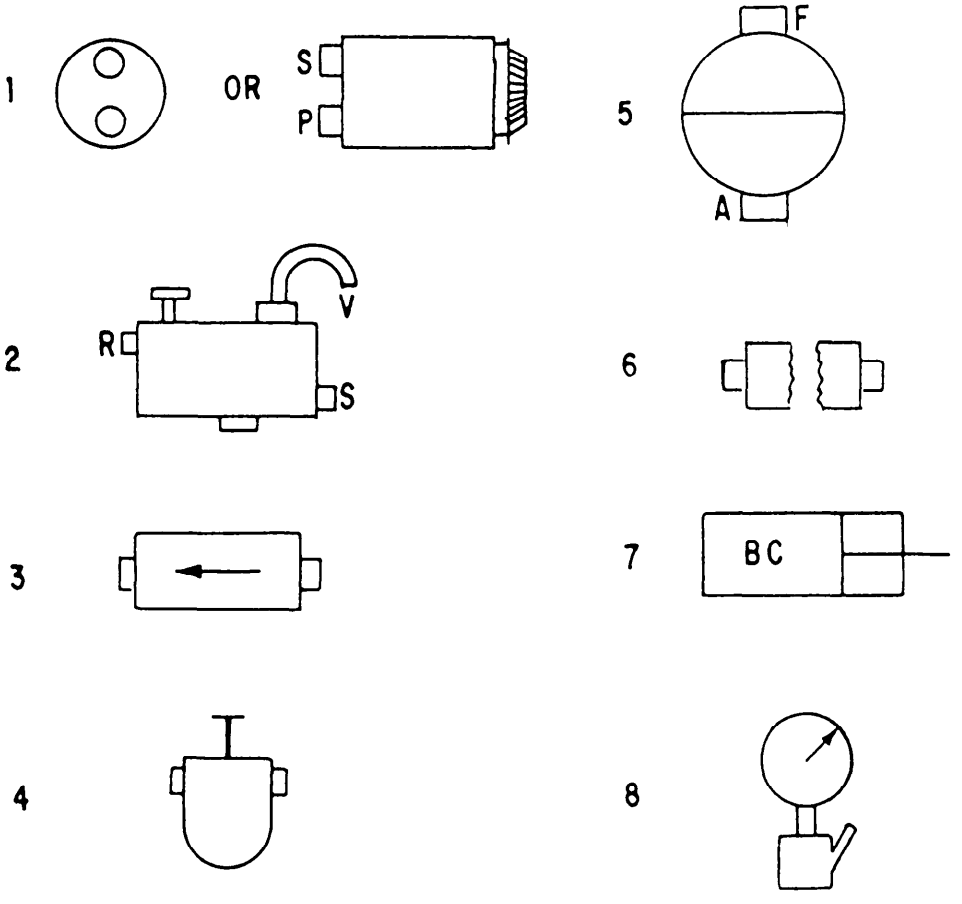
PRESSURE LINES—These lines carry only pressure. They lead from the pumps to a pressure manifold, and from the pressure manifold to the various selector valves. Or, they may lead directly from the pump to the selector valve.

OPERATING LINES—These lines alternately carry pressure to, and return fluid from, an actuating unit. They also may be called working lines. Each line is identified according to its specific function.

RETURN LINES—These lines return fluid from any portion of the system to a reservoir.

VENT LINES—These lines carry excess fluid overboard or into another receptacle.

MIL-STD-17B, part II, lists symbols that are used on hydraulic diagrams. Figure 5-16 shows the basic outline of each symbol. In the actual hydraulic diagrams the basic symbols are often improved, showing a cutaway section of the unit.



1. PUMP, POWER-DRIVEN.
2. RESERVOIR.
3. CHECK VALVE, AUTOMATIC
4. FILTER.
5. ACCUMULATOR.
6. QUICK-DISCONNECT, SELF SEALING.
7. BRAKE CONTROL UNIT.
8. PRESSURE GAUGE AND SNUBBER.

Figure 5-16.—Basic types of hydraulic symbols.

Figure 5-17 shows that the lines on the hydraulic diagram are identified as to purpose and the arrows point the direction of flow. Figure 5-18 and appendix II contain additional symbols and conventions used on aircraft hydraulic and pneumatic systems and in fluid power diagrams.

PLUMBING PRINTS

Plumbing prints use many of the standard piping symbols shown in figure 5-9. MIL-STD-17B Parts I and II lists other symbols that are used only in plumbing prints, some of which are shown in figure 5-19.

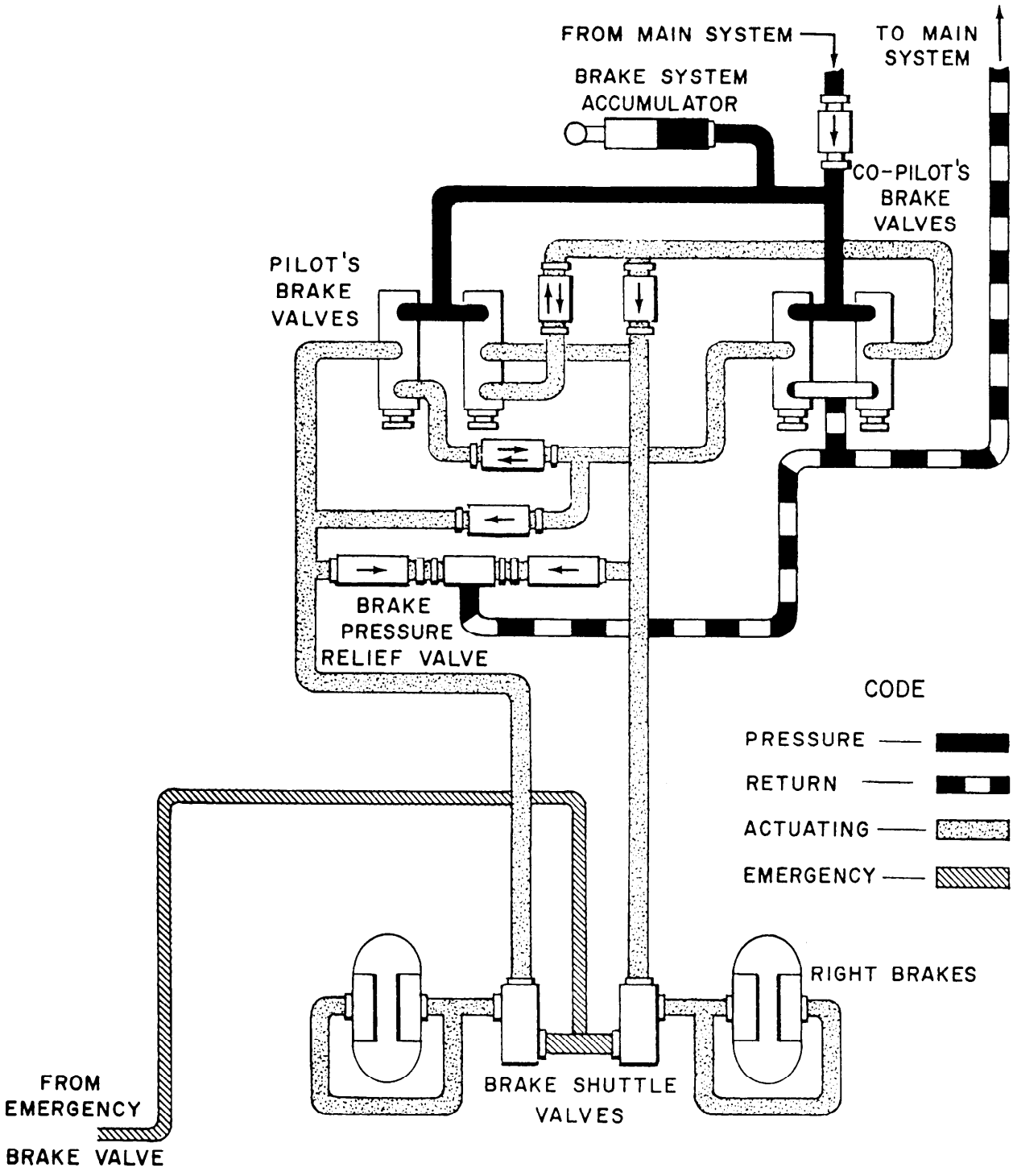


Figure 5-17.—Aircraft power brake control valve system.

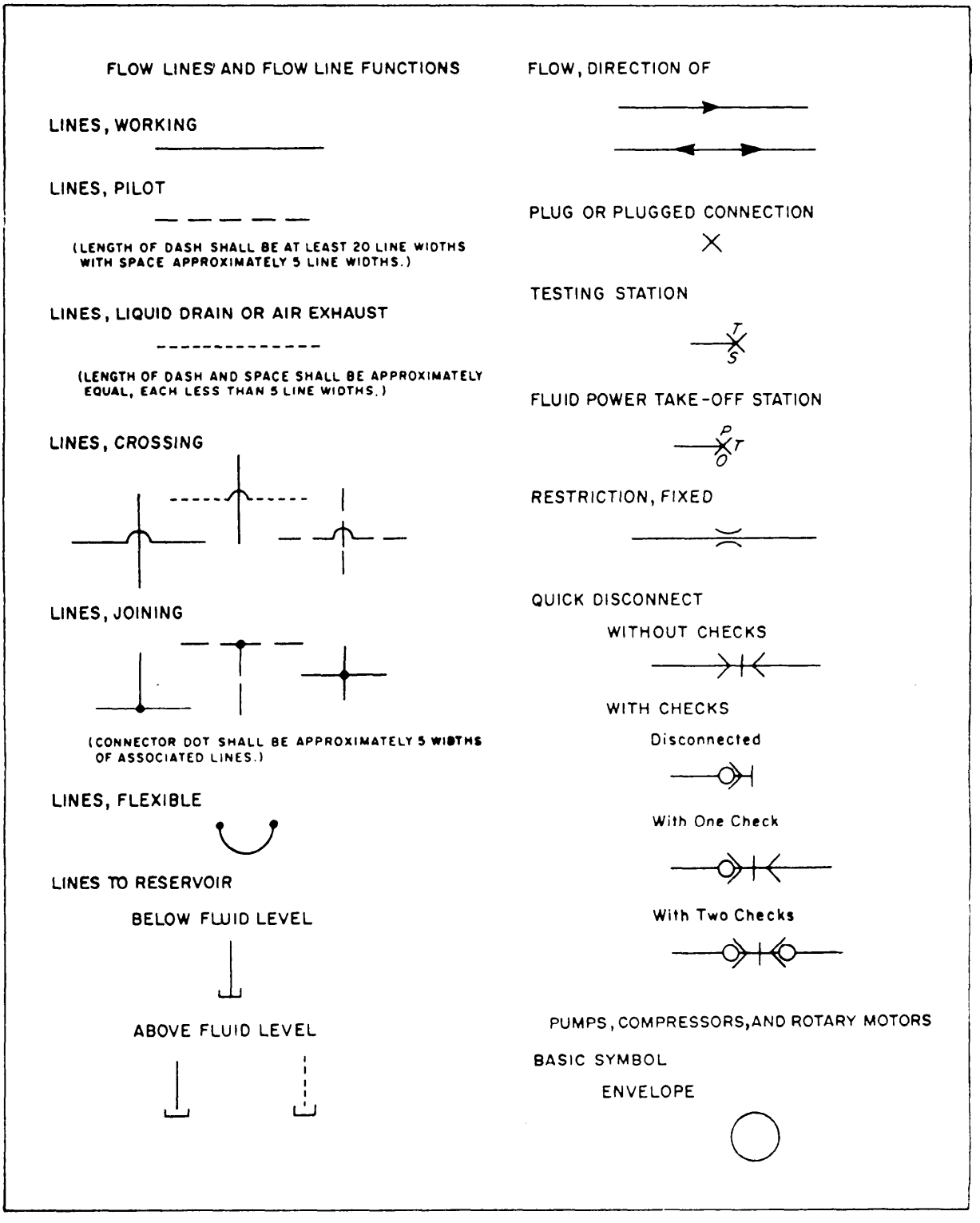


Figure 5-18.—Fluid power symbols.

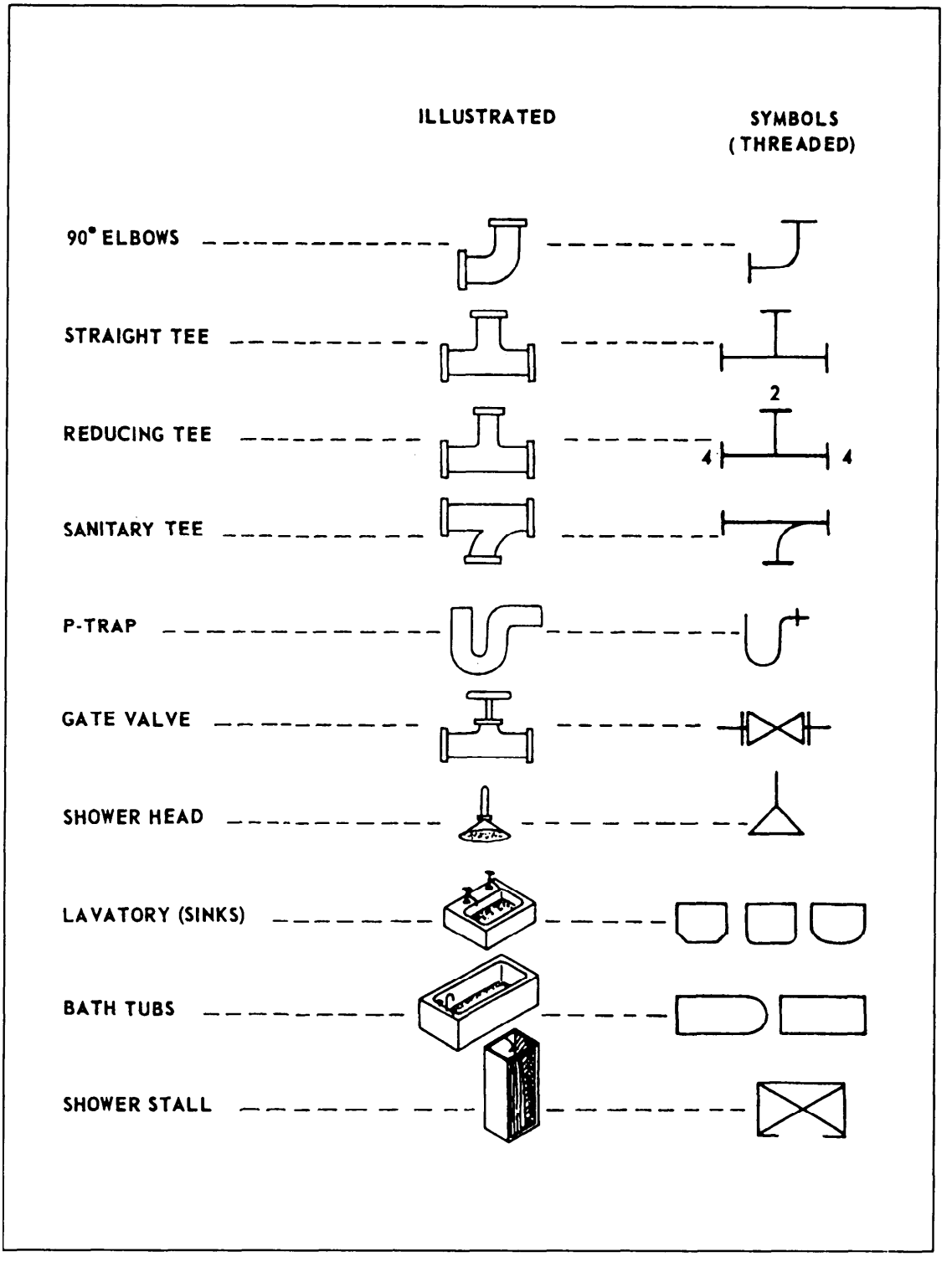


Figure 5-19.—Common plumbing symbols.

Figure 5-20 is a pictorial drawing of a bathroom. In the drawing, all that is normally placed in or under the floor has been exposed to show a complete picture of the plumbing, connections, and fixtures.

Figure 5-21, views A and B, are isometric diagrams of the piping in the bathroom shown in figure 5-20. Figure 5-22 is a floor plan of a small house showing the same bathroom, including the locations of fixtures and piping.

To interpret the isometric plumbing diagram shown in figure 5-21, view A, start at the lavatory (sink). You can see a symbol for a P-trap that leads to a tee connection. The portion of the tee leading upward goes to the vent, and the portion leading downward goes to the drain. You can follow the drain pipe along the wall until it reaches the comer where a 90-degree elbow is connected to bring the drain around the corner. Another section of piping is connected between the elbow and the next tee. One branch of the tee leads to the P-trap of the bathtub, and the other to the tee necessary for the vent (pipe leading upward between the tub and water closet). It then continues on to the Y-bend with a heel (a special

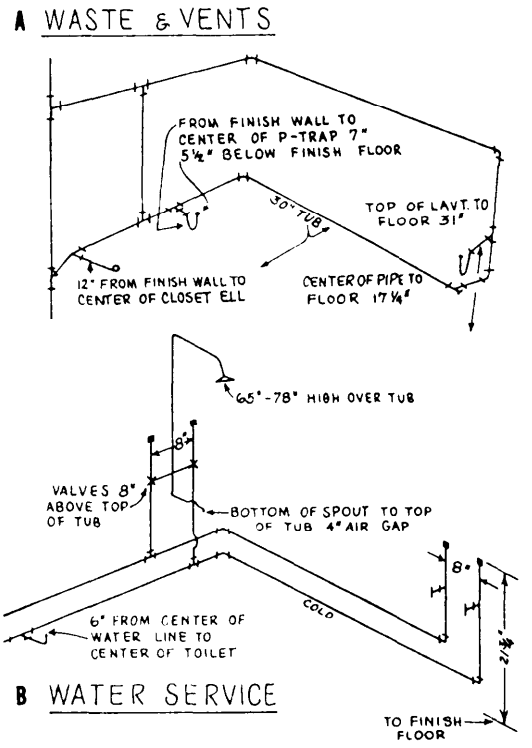


Figure 5-21.—Isometric diagram of a bathroom showing waste, vents, and water service.

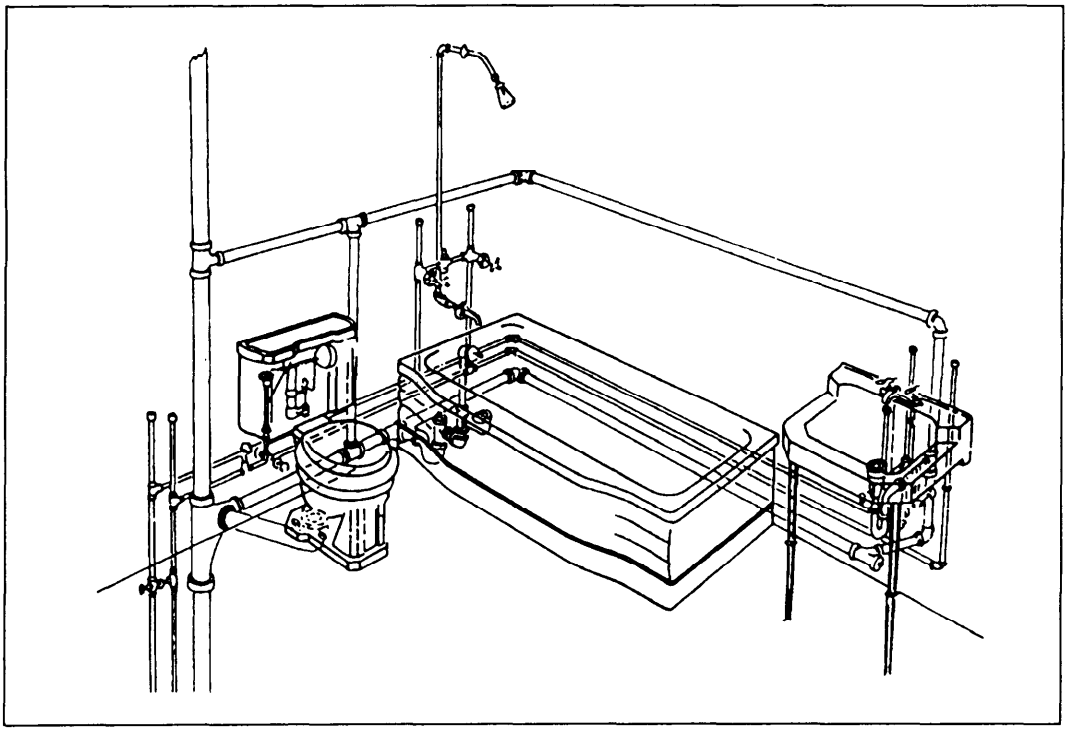


Figure 5-20.—Pictorial view of a typical bathroom.

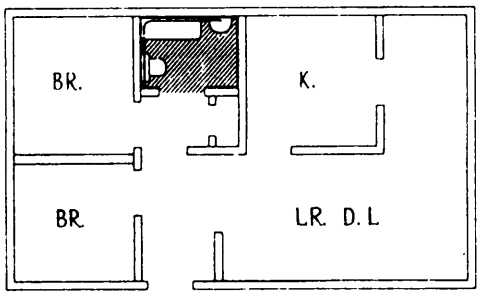


Figure 5-22.—Floor plan of a typical bathroom.

fitting) that leads to a 4-inch main house drain. The vent pipe runs parallel to the floor drain, slightly above the lavatory.

Figure 5-21, view B, is an isometric drawing of the water pipes, one for cold water and the other for hot water. These pipes are connected to service pipes in the wall near the soil stack, and they run parallel to the drain and vent pipes. Look back at figure 5-20 and you can see that the water service pipes are located above the drain pipe.

Figure 5-23 shows you how to read the designations for plumbing fittings. Each opening in a fitting is identified with a letter. For example, the fitting at the right end of the middle row shows a cross reduced on one end of the run and on one outlet. On crosses and elbows, you always read the largest opening first and then follow the alphabetical order. So, if the fitting has openings sized 2 x 1/2 by 1 1/2 by 2 1/2 by 1 1/2 inches, you should read them in this order: A = 2 l/2, B = 1 1/2, C = 2 1/2, and D = 1 1/2 inches.

On tees, 45-degree Y-bends or laterals, and double-branch elbows, you always read the size of the largest opening of the run first, the opposite opening of the run second, and the outlet last. For example, look at the tee in the upper right comer of figure 5-23 and assume it is sized 3 by 2 by 2 inches. You would read the openings as A = 3, B = 2, and C = 2 inches.

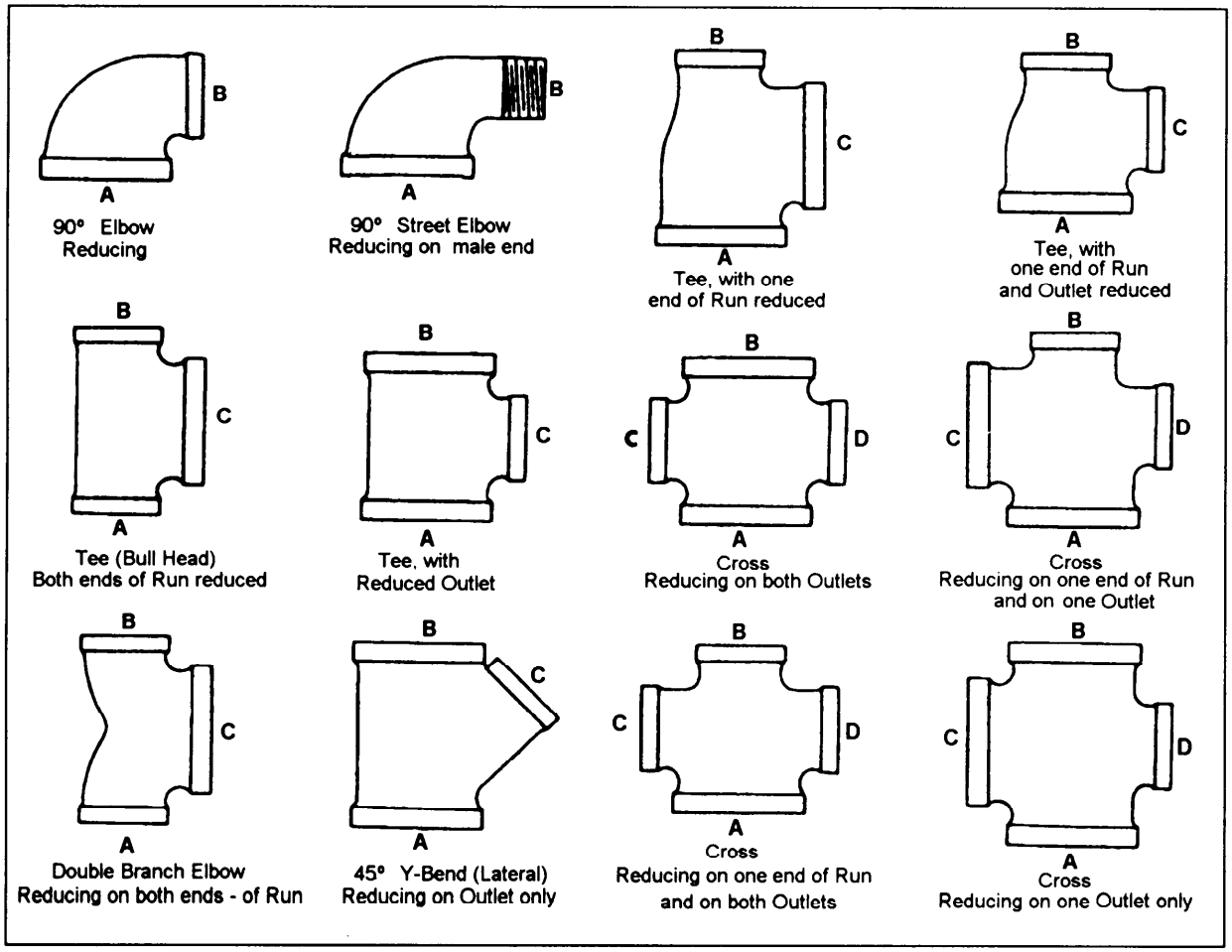


Figure 5-23.—How to read fittings.